AoIP/AES67: Anatomy of a Full-Stack Implementation

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AOIP IP STACK ON OSI LAYERS

- Layer 1: 100BASE-T, 1000BASE-% (T, X, etc.)
- Layer 2: Ethernet
- Layer 3: IPv4, IGMPv2, DiffServ
- Layer 4: UDP
- Layer 5: RTP (RTSP)
- Layer 6: PCM Audio
- Layer 7: “Network-aware” A/D-D/A
Audio over IP protocols are packet-based
Utilize connectionless, unreliable protocol – UDP
Require additional protocols
I.E. DiffServ to maintain reliable performance
I.E. IEEE1588 to keep stable clock and synchronization
I.E. IGMP to utilize network properly and efficiently
• Core of all implementations – PCM audio
• Additional functionality is required to be fully operational, configurable and user-friendly
• This functionality is provided by implementation and can vary from one to another

• How to discover devices?
• How to advertise streams?
• How to subscribe to streams?

AUDIO OVER IP IMPLEMENTATION ANATOMY

CONNECTION MEDIUM
QUALITY OF SERVICE
SYNCHRONIZATION AND CLOCK
AUDIO PAYLOAD AND ENCODING
AUDIO TRANSPORT
## IP Showcase Theatre

### Overview

- **Device Control and Monitoring**
  - HTTP, Proprietary
  - HTTP, Ember+
  - Proprietary

- **Discovery and Registration**
  - Proprietary
  - mDNS/DNS-SD (Bonjour)
  - SAP

- **Connection Management**
  - Proprietary, HTTP, IGMP
  - RTSP, SIP, IGMP
  - Proprietary

- **Session Description**
  - By channel number
  - SDP
  - Proprietary

- **Transport**
  - RTP, IPv4
  - RTP, IPv4
  - Proprietary, IPv4

- **Quality of Service**
  - Proprietary
  - IEEE 1588-2002 (PTPv2)
  - IEEE 1588-2002 (PTPv1)

- **Synchronization**
  - Proprietary
  - IEEE 1588-2008 (PTPv2)
  - IEEE 1588-2002 (PTPv1)

- **Encoding/Channel Count**
  - PCM, L24 mono, stereo, 5.1
  - PCM, L16-32 Up to 64 ch. per stream
  - PCM, L16-32 Up to 64 ch. per flow

- **Audio Payload**
  - 48 kHz
  - 44.1 – 384 kHz
  - 44.1 – 192 kHz

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**Slide concept by Merging Technologies**
### Audio

#### AES67

**UNDERSTOOD HERE**

**EBU**

*Slide concept by Merging Technologies*

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<td>SAP</td>
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**Connection management**

- IGMPv2 (multicast stream) / SIP (unicast stream)

**Session description**

- SDP (RFC 7273 for RTP clock offset announcement)

**Transport**

- RTP/AVC (RFC 3550 & 3551) over UDP over IPv4/IPv6

**Quality of Service**

- DiffServ: DSCP 46 (EF) - PTP, DSCP 34 (AF41) - RTP, DSCP 0 (BE) - else

**Synchronization**

- IEEE 1588-2008 (PTPv2), AES-R16-2016 profile is recommended

**Encoding/channel count**

- PCM, L16 (for 44.1/48 kHz) or L24 (for 48/96 kHz), 1 to 8 channels

**Audio payload**

- 48 kHz recommended default (44.1/96 kHz are possible)
RAVENNA-2-SAP AES67 CONNECTION MANAGEMENT CONVERTER
HTTPS://WWW.RAVENNA-NETWORK.COM/AES67/RAV2SAP/
ANEMAN is the first cross-platform & cross vendor audio network manager. 
HTTPS://ANEMAN.NET

DEVICE CONTROL AND MONITORING
AUDIO OVER IP IN SMPTE ST 2110

SMPTE 2110 - PROFESSIONAL MEDIA OVER MANAGED IP NETWORKS

Document structure:

- 2110-10: System Timing & Definitions
- 2110-20: Uncompressed Active Video
- 2110-21: Traffic Shaping and Delivery Timing for Uncompressed Active Video
- 2110-30: PCM Digital Audio
- 2110-31: AES3 Transparent Transport
- 2110-40: Transport of SMPTE Ancillary Data
SMPTE ST 2110-30: PCM DIGITAL AUDIO

- Defines payload format for uncompressed PCM audio
- Based on AES67
- Introduces additional constraints

SMPTE ST 2110-30: ADDITIONAL CONSTRAINTS TO AES67

- ST 2110-10 requires usage of SMPTE 2059-2 PTP profile
- AES-R16-2016 (AES67 PTP Media profile) resolves this
  - PTP setting “defaultDS.slaveOnly=true” required
  - Media clock to RTP clock offset ($\Delta t_s$) must equal zero
    ($a=mediaclk:direct=0$)
SMPTE 2110: ADDITIONAL CONSTRAINTS TO AES67

- Support for SIP **not** required
- Support for optional redundancy with SMPTE 2022-7 **required**
- Support for Channel assignment map as SDP attributes **required**

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**CONNECTION MEDIUM**

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<td>Covered in ST2110-30</td>
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</table>
• IS-04 - NMOS Discovery & Registration API
• IS-05 - NMOS Device Connection Management API
• IS-06 - NMOS Network Control
• IS-07 - NMOS Event & Tally
Minimum Stack for IP endpoints

Time and Sync
- PTPv2
- Both SMPTE and AES profiles
- BMCA for multi-interface redundancy

Configuration and Monitoring
- DHCP IP assignment
- Open configuration management (e.g., API, config file, SSH CLI, etc.)
- Open monitoring protocol (e.g., Agent-based, SNMPv3, etc.)

Media Transport
- Video SMPTE ST 2110-20/21 with Wide Rx
- Audio SMPTE ST 2110-30 Level C
- SMPTE ST 2022-7:2018 Protection
- Single link - e.g., UHD on 25 GbE

Discovery and Connection
- AMWA IS-04 Discovery and Registration
- AMWA IS-05 Connection Management
- LLDP Topology discovery

Security
- EBU R148 Tests
- HTTPS API calls
- AD, LDAP or Certificates - Authentication

2110 is only the “tip of the pyramid”

WHAT’S NEXT?..
From IP Showcase Theatre at IBC 2018  
September 2018

WHAT'S NEXT?

- Evaluate!
- Educate!
- Get your hands dirty!
- Get in touch!

IP SHOWCASE THEATRE

Thank You

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